

**DR. ASRAR KEYNOTE LUNCHEON ADDRESS TO
THE SEMINAR ON SPACE AND THE ENVIRONMENT**

February 27, 2003

[Message: NASA has clear vision of Earth system science in service to society...come with us!]

Key Points:

- 1) NASA is committed to Earth Science*
- 2) Earth system science requires an end-to-end program of observations, research, and decision support*
- 3) Only together, in a web of domestic and international partnerships, can we do the job*

Hello. I'd like to express my gratitude to the Embassy of France and the Scripps Institution of Oceanography for organizing this seminar. NASA and CNES are long-time partners in Earth Science, and this forum is an ideal opportunity to engage our expert colleagues in academia, government and industry in taking stock of our progress and the challenges ahead.

The two panels we heard from this morning gave us an exciting update on where the international Earth science community is headed in the water and carbon cycle aspects of the Earth system. The prospect of an international Global Precipitation Measurement constellation and the first capability to measure global CO₂ from space, with the commensurate research and modeling activities, are just two of areas where NASA is pleased to help make the next major contributions in these focus areas in the next few years. This afternoon we will hear about progress in the area of Solid

Earth and Natural Hazards. NASA is indebted to Sean Solomon and his team, several of whom are here with us today, for the masterful job they did in charting a course for our future in Solid Earth Science with their recent report “Living on a Restless Planet”.

I’d like to take the opportunity now to sketch out for you the bigger picture of NASA’s vision and plans for bringing new discoveries in Earth system science to bear on global change issues of international importance. I’d like to make four points today:

First, NASA is committed to Earth System Science. We pioneered space-based Earth observations and the Earth system science concept, and this remains a high priority for the Agency. And this remains a high priority for the agency in the decades ahead.

Second, progress in Earth system science comes from an end-to-end approach, from the posing of science questions to the use of new knowledge in societal decision making.

Third, we can only fulfill the potential of Earth system science, and address critical issues in global change, if we work together as agencies and nations.

Fourth, I'd like to discuss the challenges ahead that we all must work on together. These include:

- the scientific challenge of understanding the Earth system;
- the challenge of mobilizing the intellectual resources needed to turn terabytes of data into megabytes of knowledge products;
- the technological challenge of creating the observing system of the future, and;
- the educational challenge of training the next generation of Earth explorers.

Let me begin with NASA's commitment to Earth Science. One of the first achievements by Mr. Sean O'Keefe after becoming NASA Administrator was to pull the senior management of the agency together to craft a new vision and mission for NASA. Our vision is:

To improve life here,
To extend life to there,
To find life beyond.

Our Mission is:

To understand and protect our home planet;
To explore the universe and search for life;

To inspire the next generation of explorers...
As only NASA can.”

What is most striking, and most encouraging for us, in this new Vision and Mission is the prominence of Earth Science. Foremost in NASA’s vision is improving life here. Foremost in our mission is to understand and protect our home planet. While NASA’s space science, aeronautics and other programs play an important role here, the primary responsibility for fulfilling this mission element rests with the Earth Science Enterprise.

The NASA Administrator, the President, and the Congress all recognize that global change issues require a global perspective. Earth system science requires that we understand how Earth works as a planet. And NASA is in the business of studying planets. We gave the world it’s first view of global atmosphere in the 1960s, of global land surface in the 1970s, of the global oceans in the 1980s . And now with the Earth Observing System, NASA and its international partners are providing the first synoptic view of the Earth system. As we have matured these observing technologies, we have transitioned them to our operational mission partners at NOAA, at USGS, and our partners in industry, to assure their continued benefit to science and society.

Our work in ocean altimetry is a good example of this. NASA and CNES are science and technology agencies focused on research and development. Together we pioneered high precision ocean altimetry from space with the TOPEX/Poseidon and Jason missions. Now that this technology is maturing, and its benefit to climate and weather prediction is demonstrated, we are working to transition this capability to agencies with a charter to provide operational environmental satellite services. The successor mission to Jason will be a partnership among NASA, CNES, NOAA and EUMETSAT, and will result in the operational meteorological agencies taking responsibility for this measurement in the future. And we will move on to create wholly new research capabilities, such as networks of satellites whose combined power is greater than the sum of their parts.

The second point I'd like to make is that Earth system science requires an end-to-end approach, from observations to research to decision support. While we have always done all three, the emphasis in the past has been mainly on observations...on creating the technology that enables Earth system science. Prior to 1998, we were supporting the Earth science community with 2 or 3 research satellites and a basic operational environmental satellite

capability. Today, we are nearing the completion of the development and deployment of the Earth Observing System. EOS itself comprises more than 20 research satellites carrying about 90 instruments, together with the most comprehensive data and information management system ever created to support it. The US investment in EOS is matched by a nearly equal investment by our international partners, either directly in EOS or in complementary systems. And this international EOS is giving the world its first holistic look at itself. We have changed the state of Earth system science research from “data limited” to “data rich”.

We will continue to evolve EOS, transitioning mature capabilities to operational systems and adding new advanced remote sensing systems to make new kinds of observations. Even so, the emphasis is shifting now to the use of these data to understand the Earth system. NASA has nearly doubled its investment in research over the past five years; science and applications research now comprise one-third of NASA’s annual Earth Science budget.

We have developed research roadmaps for the next decade in six research focus areas that align with national and international research priorities:

- Climate variability, change and prediction
- Atmospheric composition for ozone, climate, and air quality
- Ecosystems and Carbon Cycle for climate and natural resource management
- Water and Energy Cycle research for climate & water resources management
- Weather research to improve forecast duration and reliability
- Solid Earth science for natural hazard risk assessment and mitigation

And we are leading a consortium of four federal agencies and fifteen universities in the development of a common Earth System Modeling Framework to enable development of integrated and coupled Earth system models.

Moving beyond scientific research, we are working with our partner agencies to use the vast new information and knowledge created by this observations and research efforts to be employed to improve the essential services our partner agencies provide.

Examples include enhanced weather and hurricane track prediction with NOAA, agricultural and forestry production efficiency with

the US Department of Agriculture, aviation safety with the FAA, and air quality with the EPA. It is the processes of scientific assessment and applications demonstration that take us from the realm of scientific curiosity to science in service to society.

In fact, the US interagency Climate Change Science Program Office has adopted a construct of observation & monitoring, research, and decision support tools, as well as a list of science focus areas, that closely parallels NASA's approach. As you know, the Climate Change Science Program is working on its new strategic plan, which many of you have commented on, and plans to publish its final version in the April time frame.

My third point is that partnerships are absolutely essential to progress in Earth system science. No one agency has the capacity to do what needs to be done. No one nation does either. That is why NASA works in a vast and maturing web of partnerships in Earth Science. Our long-standing partnership with CNES is an outstanding example. As I mentioned earlier, together we pioneered ocean altimetry, and we are preparing to transition this to our operational counterparts on both continents, NOAA and EUMETSAT. Our collaboration in the Oceans Theme of the Integrated Global Observing Strategy is another example. In this

case, the many IGOS-participating nations articulate a grand vision for global cooperation. And a few nations got together to move out with the Ocean Theme, to show how the grand vision might ultimately be achieved. CNES' MERCATOR modeling project and NASA, NOAA, and the US Navy's joint ocean modeling work are two elements of this ocean theme that demonstrate the value and necessity of collaboration for success beyond obtaining observations.

Next year, NASA, CNES, and other partners will begin launching a series of atmosphere observing satellites that will fly in formation as a network. The US/UK/Dutch EOS Aura mission that will probe the dynamics and chemical composition of both the stratosphere and troposphere. The US/France CALIPSO satellite and the US/Canadian Cloudsat satellite will open the new frontier of active remote sensing of the atmosphere, probing its 3-dimensional structure to illuminate the complex atmospheric physical and chemical processes that control climate/chemistry connections. Operating these satellites as a network and combining their data will dramatically enrich the scientific return over what would be achieved if we had implemented them independently. Together, they comprise an international, integrated observing system for cutting-edge atmospheric research.

NASA's Earth Science Enterprise has some 200 agreements with 60 nations around the world for the conduct of joint observing and research programs. And our partnerships with academia and industry are growing as well. These partnerships are growing in depth as well as number as new observations enable new research and applications.

Fourth and finally, I'd like to highlight for you the challenges ahead as we see them. And there are four of these. First is the scientific challenge of understanding the Earth system. What is it that makes planet Earth unique as a safe harbor for highly diversified life? What is the nature of the cosmic thermostat regulating climate on Earth that is absent from the barren Mars or the runaway greenhouse of Venus? We know the relative stability of the climate system on Earth owes much to its carbon and water cycles. We know that human activities are tinkering with these cycles; but will our activities upset this balance to a degree harmful to Earth's ability to sustain life, or to sustain our society as we know it?

The second challenge is to bring to bear the intellectual power needed to transform the petabytes of data we are beginning to

generate into the megabytes of knowledge products useful to scientists and decision-makers. Upstream, we need to be able to generate the climate data records and Earth system process descriptions needed for scientists to answer the questions I posed earlier. Downstream, we must be able to translate our new scientific understanding into knowledge products that decision makers in national and local governments, business and the general public can use. This challenge was just highlighted in a powerful way by the National Research Council in its review of the US Climate Change Science Program strategic plan. Earth system science is science in service to society; we must work to make that connection between science and decision-making.

The third challenge is to design and implement the integrated Earth observing system of the future. Building on the initial capability we are deploying today, the observing system of the future must be progressively more flexible and evolvable. It must be focused on information synthesis and delivery of knowledge to users in a timely and affordable manner. Such a system must not be constrained by today's technologies. It must be based on standards and protocols that enable "plug compatible" additions from a variety of partners around the globe, analogous to the open architecture of the Internet.

The fourth challenge is to train the next generation of scientists, engineers, and technologists. We need a work force capable of exploiting the data we are generating today, and one that can plan and implement the observing system and knowledge generation pathways of the future. Those young people are already in school today, and we are in just the beginning stages of revolutionizing the way Earth system science is taught along the whole K-16 pipeline.

The excitement of exploration and discovery of Earth system science is now transcending the scientific community and reaching the fabric of our economy and societal decision-making.

Continued scientific progress requires even more collaboration in the future. And we will undoubtedly continue by building on our most productive historical partnerships, such as that between NASA and CNES.

Ultimately, the mission to understand and protect our home planet belongs to all of us, whether government, industry, or academia. Seminars like this are a good reminder of that fact, and provide momentum to our collective efforts. Thank you for the opportunity to address you today,.

